# APPENDIX ‘A’

# GEOTECHNICAL INVESTIGATION FOR 1919 STRIKE MONUMENT

Submitted to: **Monteyne Architecture Works**

# GEOTECHNICAL INVESTIGATION – 1919 STRIKE MONUMENT

## 145 MARKET AVENUE
## WINNIPEG, MB

**NOVEMBER 2016**

**FILE NO. 16-284-02**

ENG-TECH
CONSULTING LIMITED

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## ATTACHMENTS

## 1.0 INTRODUCTION

ENG-TECH Consulting Limited (ENG-TECH) completed the requested geotechnical investigation at 145 Market Avenue in Winnipeg, MB. ENG-TECH understands that the project consists of an installation memorializing the 1919 Winnipeg General Strike, which will be installed in the space beside 145 Market Avenue. The purpose of the investigation is to provide recommendations related to friction piles.

### 1.1 Scope of Work

ENG-TECH completed the following scope of work:

- Clearance of public utilities.
- A test hole drilling and soil sampling program.
- A laboratory testing program.
- An assessment and engineering report.

## 2.0 TEST HOLE DRILLING, SOIL SAMPLING, LABORATORY TESTING

ENG-TECH supervised the drilling of a test hole on October 19, 2016 at the location shown on Figure 1. The test hole was drilled using a track mounted Acker MP% drill rig equipped with 125 mm diameter solid stem continuous flight augers owned and operated by Maple Leaf Drilling Ltd. TH1 was advanced to 12.2 m below grade and was backfilled using the auger cuttings and bentonite upon the completion of drilling.

The soil stratigraphy was visually classified at the time of drilling using the modified Unified Soil Classification System (USCS). Soil samples were collected off the auger flights and by means of Shelby Tube at depths of 4.6 and 7.6 m below existing grade. All soil samples collected were retained for testing in ENG-TECH's Winnipeg laboratory.

Moisture contents were determined on all soil samples collected (13), while two (2) unconfined compressive strength tests were completed on select samples. The results are shown on the test hole summary logs.

## 3.0 STRATIGRAPHY

Overall, the stratigraphy at the test holes consisted of 3.0 m thick layer of gravel fill over native clay to the depth explored. The gravel fill was medium brown, moist, dense, poorly graded, medium grain, and contained trace cobbles and construction debris. The native clay was dark brown, moist, firm, highly plastic, and contained trace silt, but became grey with increased depth.

Sloughing was observed at 11.3 m below grade in the test hole, with no seepage occurring in the test hole after drilling. Detailed stratigraphy descriptions are outlined on the test hole summary logs.

## 4.0 RECOMMENDATIONS

### 4.1 General

Based on the soil conditions and the magnitude of the monument loads, shallow foundations such as rafts would likely be more economical compared to deep foundations such as cast-in-place concrete friction piles; however, shallow foundations are more prone to vertical and differential movements than piles. Shallow foundations, such as rafts, would be suitable to support smaller lightly loaded structures and modifications, provided the owner is willing to accept the risk of total movements in the order of 25 mm based on using a geotechnical factor of 0.5. The expected differential movements are usually half of the total movements. Deep foundations such as cast-in-place concrete friction piles are more suitable for heavier loads. Other foundation types could also be used to support proposed structures, although they were not considered to be as practical or economical as the above options. As such, only recommendations for concrete cast-in-place friction piles will be presented in this report.

### 4.2 Foundation

#### 4.2.1 Cast-in-place Concrete Friction Piles

Cast-in-place concrete friction piles were assessed using a geotechnical resistance factor of 0.4 to obtain the ULS and SLS values that can be used in design as outlined in Table 1 below for vertical resistance:

**Table 1**
**ULS and SLS Skin Friction Static Resistances for Cast-In-Place Concrete Piles**

| Depth Range (m) | ULS Skin Friction Resistance | SLS Skin Friction Resistance |
|---|---|---|
| | kPa | |
| The greater of: 2.5 m below existing grade or 1.0 m below the underside of the grade beam | 0 | 0 |
| Between the above and 9.0 m below existing grade | 12 | 10 |
| Between the above and 12.0 m below existing grade | 5 | 4 |

The following recommendations also apply to the use of cast-in-place concrete friction piles:

- The piles should be spaced at least 2.5 pile diameters apart, as measured from center to center in order to have the piles act individually. For a two (2) pile group, the capacity per pile as outlined above could be used to establish the capacity of the group.

- A minimum embedment depth of 6.5 m must be used for all piles located within the interior and a minimum embedment depth 8 m must be used for all piles located on the perimeter of the building and in unheated areas.

- The piles may be treated as supported columns throughout their depth below final grade.

- The weight of the embedded portion of the pile may be neglected in the design when determining the load on a pile.

- Each pile must be reinforced to at least 6 m, with reinforcement to resist up-lift pressures due to structural forces as determined by the structural engineer. The design of piles to resist up-lift from soil swell pressure is not required for all piles since significant differential changes in moisture content are not expected around the piles with depth. Vertical reinforcement may also be required to resist breaking of the upper portion of the piles as a result of up-lift forces due to frost action against perimeter piles and piles in unheated areas. The use of a Sona tube wrapped with a layer of 4 mil poly and inserted in the upper 2.5 m of the bore holes prior to placement of concrete will aid to reduce the potential of uplift pressures on the piles due to frost. This should be done for all piles located along the perimeter of the building and in unheated areas.

- The piles should be poured immediately after the completion of drilling to reduce the potential for seepage in the boreholes, and sloughing, swelling and squeezing of the boreholes, and should be poured in accordance with Clause 7.2.7 of the Canadian Standards Association A23.1-14 (Concrete Materials and Methods of Concrete Construction). Some seepage and sloughing should be expected during the installation of cast-in-place piles. Steel sleeving varying in length (including to full length) may be required for some piles, while pumping may be required to remove excess water from some boreholes prior to pouring the concrete. Steel sleeves & a pump should be available on site and used on an as required basis.

- A minimum compressible void form of 150 mm should be maintained under all pile caps, grade beams, and structures supported on piles to prevent damage due to uplift pressures and potential swelling of the underlying soils, should it occur.

### 4.3 Foundation Concrete

General

All concrete should be designed, specified, and constructed in accordance with CSA standard A23.1-14, Concrete Materials and Methods of Concrete Construction using the Performance Specification Alternative as outlined in Table 5 of CSA A23.1-14.

Under the performance alternative, the concrete supplier shall assume responsibility for the performance of the concrete as delivered and the contractor shall assume responsibility for the concrete in place. The owner shall specify performance requirements including: the required structural criteria and concrete strength at age, the concrete exposure class for durability, and any other properties that may be required to meet the owner's performance requirements such as colour, architectural requirements, and special surface finishes. The owner reserves the right to request the supplier provide satisfactory documentation that the proposed mix design will achieve the strength, durability, and performance requirements specified by the owner, and that the mix design satisfies the requirements of CSA A23.1-14. In addition, the owner may request the contractor submit documentation demonstrating the owner's performance requirements have been met during construction and placement.

Based on Tables 1, 2, 3, and 4 of CSA A23.1-14, the concrete in contact with the local soils can be classified as a N exposure class for the floor slab in a continuous heated building which will not be exposed to chlorides or freezing, C-2 exposure class for the raft and S-2 exposure class for the

piles and pile caps, and should be designed to meet the minimum specifications outlined below for durability.

Piles and Pile Caps (S-2)

56 day minimum compressive strength of 32 MPa
Maximum water/cementing materials ratio of 0.45
Maximum nominal aggregate size of 20 mm
Type HS or HSb cement
Air content of 4-7%

## 5.0 CLOSURE

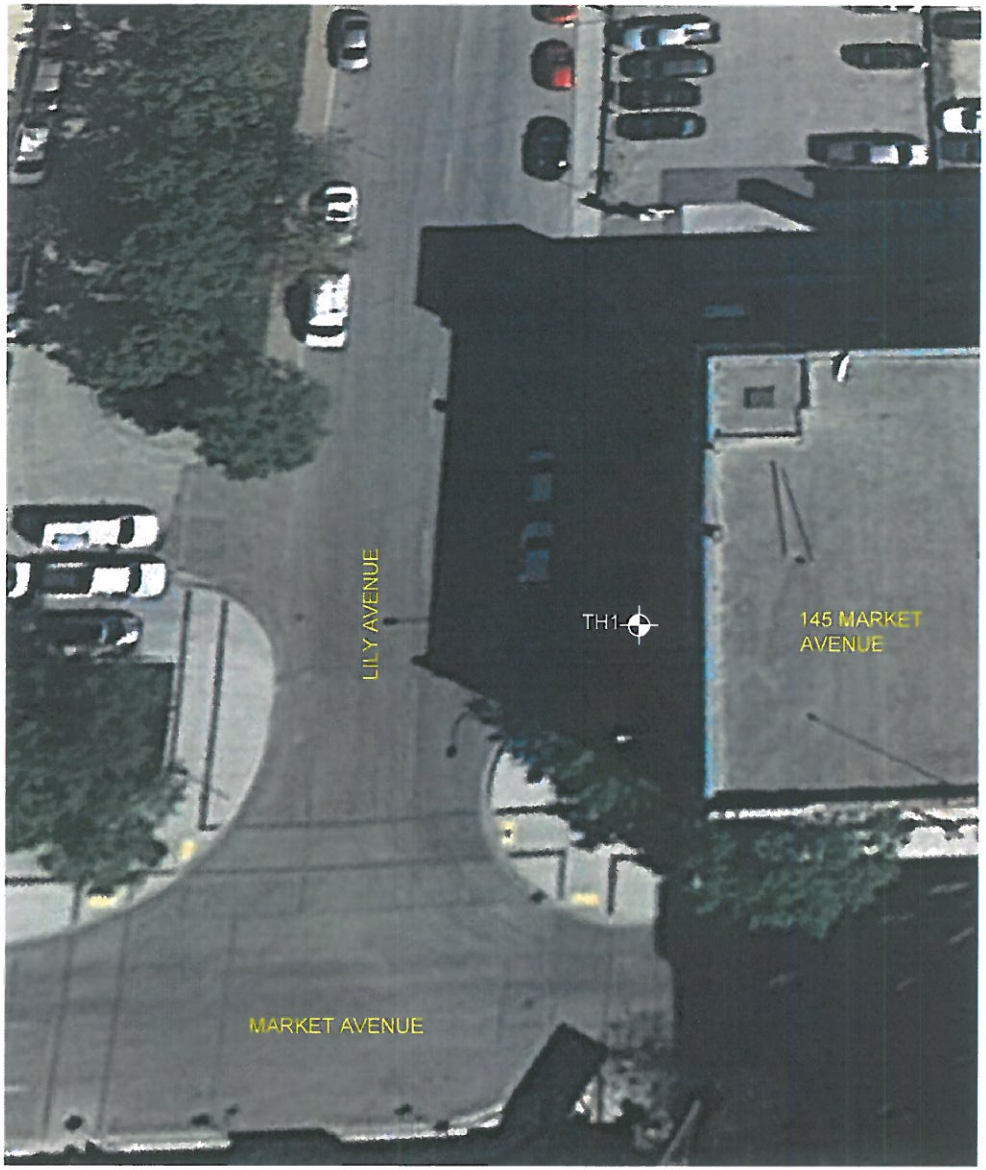
This report was based on the scope of work outlined for the purpose of the investigation, and was prepared in accordance with acceptable professional engineering principles and practices. If you have any questions, please contact the undersigned.

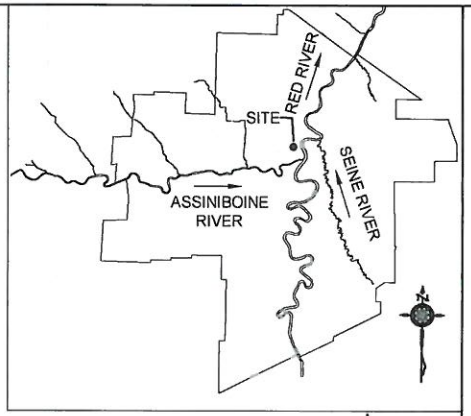
Sincerely,
ENG-TECH Consulting Limited


Clark Hryhoruk, M.Sc., P.Eng.
Principal, Geotechnical Engineer

CDH/tdr

APEGM
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475 Expiry: April 30, 2017




KEYMAP

N

LEGEND

TEST HOLE

| TEST HOLE LOCATION TABLE | | |
|---|---|---|
| HOLE # | GPS COORDINATES OF TEST HOLES OCTOBER 19, 2016 | |
| | UTM | 14U |
| TH 1 | 5529048 | 0633851 |

| NO. | DATE | ISSUE / REVISION |
|---|---|---|
| 0 | NOV.2016 | Report |

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APEGM
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475 Expiry: April 30, 2017

CLIENT:
MONTEYNE ARCHITECTURE WORKS

PROJECT:
GEOTECHNICAL INVESTIGATION
1919 STRIKE MONUMENT, 145 MARKET AVENUE, WINNIPEG, MANITOBA

DWG DESCRIPTION:
SITE & TEST HOLE LOCATION PLAN

SCALE:
NTS

DRAWN BY: TDR
DATE: OCTOBER 2016

FILE No.: 16-284-02
CLIENT DWG/FIG. No.:

ENG-TECH DWG/FIG. No.: 1
NO.:

P:\2016\Projects\284(Monteyne Architecture Works)\02(1919 Strike Monument)\Figure1 - Site & Test Hole Location Plan.dwg

## MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

| MAJOR DIVISION | | | GROUP SYMBOL | GRAPH SYMBOL | TYPICAL DESCRIPTION | LABORATORY CLASSIFICATION CRITERIA |
|---|---|---|---|---|---|---|
| COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75 µm) | GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75 mm | CLEAN GRAVELS (TRACE OR NO FINES) | GW | | WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES | $C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ TO 3 |
| | | | GP | | POORLY GRADED GRAVELS, GRAVEL- SAND MIXTURES, LITTLE OR NO FINES | NOT MEETING ABOVE REQUIREMENTS |
| | | DIRTY GRAVELS (WITH SOME OR MORE FINES) | GM | | SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES | ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4 |
| | | | GC | | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES | ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7 |
| | SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75 mm | CLEAN SANDS (TRACE OR NO FINES) | SW | | WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES | $C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ TO 3 |
| | | | SP | | POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES | NOT MEETING ABOVE REQUIREMENTS |
| | | DIRTY SANDS (WITH SOME OR MORE FINES) | SM | | SILTY SANDS, SAND-SILT MIXTURES | ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4 |
| | | | SC | | CLAYEY SANDS, SAND-CLAY MIXTURES | ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7 |
| FINE GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75 µm) | SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT | LL ≤ 50% | ML | | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHTY PLASTICITY | CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW) |
| | | LL > 50% | MH | | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS | |
| | CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT | LL ≤ 30% | CL | | INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS | |
| | | 30% < LL ≤ 50% | CI | | INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS | |
| | | LL > 50% | CH | | INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS | |
| | ORGANIC SILTS & CLAYS BELOW "A" LINE | LL < 50% | OL | | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY | |
| | | LL > 50% | OH | | ORGANIC CLAYS OF HIGH PLASTICITY | |
| HIGHLY ORGANIC SOILS | | | Pt | | PEAT AND OTHER HIGHLY ORGANIC SOILS | STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE |

### ADDITIONAL SYMBOLS

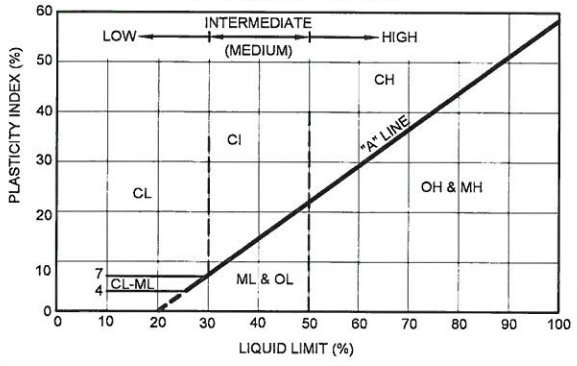
| | | | |
|---|---|---|---|
| TILL | | SANDSTONE | |
| | | GRANITE | |
| FILL | | | |
| TOPSOIL | | | |
| CONCRETE | | | |
| SHALE | | | |
| LIMESTONE | | | |

### PLASTIC SOILS

| MOISTURE | PLASTICITY | INTRUSIONS | CONSISTENCY | POCKET PEN (TSF) | (N) |
|---|---|---|---|---|---|
| DRY | LOW | ROOTLETS | VERY SOFT | | < 2 |
| DAMP | MEDIUM | OXIDES | SOFT | 0 - 0.5 | 2 - 4 |
| MOIST | HIGH | MICA | FIRM | 0.5 - 1.0 | 4 - 8 |
| WET | | GYPSUM | STIFF | 1.0 - 2.0 | 8 - 15 |
| | | ETC. | VERY STIFF | 2.0 - 4.0 | 15 - 30 |
| | | | HARD | > 4.0 | > 30 |

TSF x 95.8 = kPa ($q_U$) $S_U = \frac{1}{2} \times q_U$

### PLASTICITY CHART FOR SOILS PASSING 425 µm SIEVE




### SOIL DESCRIPTIONS

| | | | | | |
|---|---|---|---|---|---|
| TRACE: | 0 - 10% | BOULDERS: | > 200 mm | COARSE SAND: | 2 - 4.75 mm |
| SOME: | 10 - 20% | COBBLES: | 75 - 200 mm | MEDIUM SAND: | 0.425 - 2 mm |
| WITH: | 20 - 35% | COURSE GRAVEL: | 19 - 75 mm | FINE SAND: | 0.075 - 0.425 mm |
| AND: | 35 - 50% | FINE GRAVEL | 4.75 - 19 mm | FINES: | < 0.075 mm |

### GRANULAR SOILS

| MOISTURE | DENSITY | GRADATION | INTRUSIONS | SPT (N) |
|---|---|---|---|---|
| DRY | VERY LOOSE | POORLY | ROOTLETS | 0 - 4 |
| DAMP | LOOSE | WELL | OXIDES | 4 - 10 |
| MOIST | MED. DENSE | | MICA | 10 - 30 |
| WET | DENSE | | FINES | 30 - 50 |
| | VERY DENSE | | ETC. | > 50 |

DEFINITIONS

LL = LIQUID LIMIT
P.I. = PLASTICITY INDEX
$C_U$ = COEFFICIENT OF UNIFORMITY
$q_U$ = UNCONFINED COMPRESSIVE STRENGTH
$S_U$ = UNDRAINED SHEAR STRENGTH
$C_C$ = COMPRESSION INDEX
PL = PLASTIC LIMIT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## Test Hole #: TH1

**Client:** Monetyne Architecture Works
**Site:** See Figure 1
**Location:** 145 Market Avenue, Winnipeg, MB
**Project:** Geotechnical Investigation - 1919 Strike Monument

**File No.:** 16-284-02
**Date Drilled:** October 19, 2016
**Grade Elevation:** 100.0 m
**Water Elevation:** --

| Depth (m) | Soil Symbol | Description | Elevation (m) | Sample No. | Sample Type | Moisture Content (%) | Blows/300 mm | P. Pen | Torvane | UC |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | | Ground Surface | 100.0 | | | | | | | |
| 0.0 | | ***Gravel Fill (GP)*** -medium brown, dry, dense, poorly graded, medium grained, trace cobbles and construction debris. | | S1 | | 5.2 | | | | |
| 1.0 | | | 99.0 | S2 | | 4.1 | | | | |
| 2.0 | | | 98.0 | S3 | | 8.8 | | | | |
| 3.0 | | ***Clay (CH)*** - dark brown, moist, firm, highly plastic, trace silt. | 97.0 | S4 | | 47.0 | | 36 | | |
| 4.0 | | | 96.0 | S5 | | 50.9 | | 24 | | |
| 5.0 | | | 95.0 | S11 | | 22.3 | | | | |
| 6.0 | | - below 6.1 m, dark brown to grey. | 94.0 | S6 | | 54.5 | | 24 | | |
| 7.0 | | | 93.0 | S7 | | 46.3 | | 12 | | |
| 8.0 | | | 92.0 | S12 | | 47.3 | | | 44.1 | 63.4 |
| 9.0 | | - below 9.1 m, grey, soft. | 91.0 | S8 | | 46.9 | | 24 | | |
| 10.0 | | | 90.0 | S9 | | 49.5 | | | 10 | |
| 11.0 | | | 89.0 | S13 | | 59.6 | | | | |
| 12.0 | | | 88.0 | S10 | | 54.8 | | | 10 | |
| 12.0 | | ***End of Test Hole*** - end of test hole at 12.2 m below grade. - sloughing observed within clay layer at 11.3 m below grade upon completion of drilling. - no seepage was encountered upon completion of drilling. - test hole was backfilled with bentonite and soil cuttings upon completion of drilling. | | | | | | | | |
| 13.0 | | | 87.0 | | | | | | | |
| 14.0 | | | 86.0 | | | | | | | |
| 15.0 | | | 85.0 | | | | | | | |
| 16.0 | | | 84.0 | | | | | | | |

Moisture Content (%): PL I----------X----------I LL (20, 40, 60, 80)

SHEAR STRENGTH (kPa)

ENG- TECH Consulting Limited

Logged by: TDR

Reviewed by:

Drilled By: Maple Leaf Drilling Ltd
Drill Rig: Acker MP5
Auger Size: 125 mm SS

Completion Depth: 12.2 m
Completion Elevation: 87.8 m
Sheet: 1 of 1

SAMPLE TYPE: SPLIT BARREL, SHELBY TUBE, AUGER CUTTINGS, SPLIT SPOON